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Statement of

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Administrator

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

before the

Subcommittee on Retailing, Distribution,
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of the
Select Committee on Small Business
United States Senate

Mr. Chairman and Members of the Subcommittee:

The hearings of this Subcommittee on the relation of scientific knowledge and technological resources to the health, growth and balance of the national economy go to the heart of a number of the most important questions before the Nation at this time. The process of pushing forward the frontier of scientific discovery and the conversion of the knowledge gained to practical use touches every aspect of our national life. The wisdom with which we take the necessary steps to develop and use our scientific and technical resources may well determine our ability as a Nation to survive and prosper.

Thoughtful students of the forces at work in our society recognize that the exact relation of technological resources to the various factors which affect our national economy is imperfectly understood at this time. In certain areas it is not difficult to measure a direct and predominant effect of science and technology upon economic growth. At the same time, mature study usually indicates that the final economic result is determined by an interaction between science and technology, on the one hand, and other economic factors, such as entrepreneurial initiative, or national resources, or access to markets, on the other hand. More rigorous analysis of this process is urgently needed, and I am glad to note that increased attention is being given to this problem in the universities, in the Government, and in the private sector.

Whatever our limitations in understanding, however, events of recent years have produced general agreement that advances in science and technology have become an indispensable element in the maintenance and growth of any modern economy. In the mind of the economist, technological resources now stand in importance with the traditional resources of land, labor and capital, and with such other factors as entrepreneurship and managerial capacity. Where technological resources or advances are absent, or are not effectively organized and managed, then other types of economic resources will not be quickened to optimum effectiveness in the market place. To attempt to maintain a growing economy without the necessary accompanying technological resources would be comparable, at an earlier time, to have attempted to enter fully into the industrial age without access to the basic resources of power and mineral ores. It is essential, therefore, that we take vigorous steps to determine, only approximately, if that is the best we can do in the beginning, the level of technological resources necessary for satisfactory growth in various segments of the American economy. Coupled with regional analyses of needs and opportunities, these steps offer even greater promise for energizing planning and action.

In seeking answers to these problems, it is not possible to ignore the fact that increasing use of science and technology is required to sustain the desired position of the Nation in the present world situation. A firm base of the national position, of course, is the maintenance of the strength of the national economy. Our Nation must meet the immediate needs of defense and of the pursuit of certain broad areas of science, such as medicine and health, the exploration of space, and atomic energy. These and others have claims upon our scientific and technological effort at any given time.

As a Nation, therefore, we are confronted with the task of meeting many needs in the short run, and, in the long run, of creating those basic conditions in American life that will insure (1) adequate training of scientists, engineers, and technicians; (2) the wise support of basic research; and (3) an effective organization and management of scientific and technical resources for economic and other national purposes.

In relative terms, we are confronting a new problem. It is only recently that science and technology have become so decisive in effect and so dependent for success on large-scale organized effort. In short, we are presently going through the rigorous process of incorporating a new, all pervasive, vital element into our national life, of creating those technological resources and reorientations of viewpoints that will make it possible to meet any need of the future.

The accomplishment of this task requires response from all areas of our national life. Our educational system is seriously involved. The development of scientists and engineers begins at least as early as the first grade. At the other end of the educational scale are our colleges and universities. We require more and stronger institutions of high and increasing quality distributed broadly over the Nation. There is need in the universities for an expansion of basic science training and research. At the same time, a stronger bridge in the educational process must be built between the scientist who is advancing the frontier of knowledge and the engineer and manager of industrial production who must convert basic science into practical and economic application. This is a vital point in the total process; as much as any single factor, advance here would increase the economic output per unit of our existing and future technological resources. Without it, the effect of a mere increase in quantity of these resources will be seriously diminished. In the private economy, and particularly from a local or metropolitan area, or regional viewpoint, there is needed a thorough study of those factors that will identify and increase and facilitate research of greatest promise, and that will translate all knowledge gained from research quickly into policy and action, alike for industrial leaders and public officials. The record clearly indicates that in a number of broad industrial areas and regional patterns this process does not now operate effectively. We need to understand better the conditions under which science and technology can be made economically available for early use by small, as well as large, enterprises. Similarly, we need to do all that we properly can to encourage the establishment of needed technological resources in those regions where they do not now exist. And we must take the steps necessary to make the great flood of scientific and technical information more readily available to potential users.

As an important part of this total process of building technological resources, using them, and incorporating them into the national economy, NASA has heavy responsibilities. I would like to indicate briefly some of the ways in which we are attempting to meet these responsibilities.

While maintaining sufficient in-house competence to insure responsible management of the space effort, NASA spends approximately ninety cents of every dollar with private industry, thus encouraging the growth of research and development under private management. The portion going to industry this year is 93 percent.

NASA has examined carefully its employment of scientists and engineers in relation to the needs of the total national economy. The facts indicate that the space program is not having a harmful effect by creating shortages of personnel. The NASA requirement situation may be summarized as follows:

1. Our studies show that on January 1, 1960, 8,400 scientists and engineers were employed on the NASA program--approximately 5,000 contractor employees and 3,400 NASA employees.

2. They show that on January 1, 1963, 43,500 scientists and engineers were employed on the NASA program--approximately 34,300 contractor employees and 9,200 NASA employees.

3. The ratio of NASA to contractor scientists and engineers which was approximately 1:2 in January 1960 decreased to approximately 1:3 in January 1963 and is expected to be about 1:4 in January 1964.

4. NASA's projected total requirements for scientists and engineers on January 1, 1964, would increase to about 64,000, based on proposed budget levels and expenditure rates which will not now be achieved. However, of this total, it was estimated that 53,000 would work for contractors and the remaining 11,000 would be in NASA.

The NASA requirements are related to total national requirements as follows:

1. On January 1, 1960, the total NASA program employed less than one percent of the Nation's estimated 1.2 million scientists and engineers.

2. Before current cutbacks, NASA's total requirements were estimated to increase to 4.3 percent of total national requirements of 1.5 million by January 1, 1964.

Estimates soon to be published by the Bureau of Labor Statistics, place the 1970 total supply of scientists and engineers at about 1,700,000. It is not likely that the percentage required for NASA work will substantially increase unless current budgetary levels are increased.

In the manpower field generally, we are embarrassed by a lack of real understanding of the underlying relationships in what is essentially a dynamic situation. The kind of work needed to increase understanding and make possible better predictions is illustrated by a limited survey made by NASA of its largest research and development contractors to collect data on the number of scientists and engineers working on NASA contracts in relation to the expenditures on these contracts. This survey provided an opportunity to determine the increases in scientists and engineers and the relationships of these to increased expenditures in these particular companies which were occurring as a result of NASA work. Not all the companies were able to provide data for each year, so the number of companies represented in any year varies somewhat. However, even with such limiting factors, these data show that during the calendar year 1961 NASA placed an increased demand on nine companies equivalent to 3,479 scientists and engineers. During the same year, these companies increased their company-wide total number of scientists and engineers by 4,205, a somewhat larger number. In these nine companies, there may have been some absorption of NASA work without equivalent increases in the number of scientists and engineers, but it was not revealed by this gross data.

In calendar year 1962, NASA placed an increased demand on 11 companies equivalent to 8,352 scientists and engineers. These companies increased their company-wide total number of scientists and engineers by 7,708, a somewhat smaller number. Therefore, for these 11 companies it appears reasonable to assume an absorption rate of approximately eight percent.

In calendar year 1963, the increased demand occasioned by NASA work was estimated at 4,005 scientists and engineers among <u>seven</u> companies. However, these companies have indicated they increased their scientific and engineering staffs by only 2,899. Thus in 1963, the data indicate approximately a 28 percent absorption factor for NASA work without equivalent contractor increases in scientific and engineering manpower.

These limited analyses appear to indicate that the aerospace industry has some ability to place scientists and engineers on new NASA work without a proportional increase in recruiting from outside the company or proportional increases in staff. This ability seems to be increasing as aerospace companies move from conceptual and preliminary design stages of the new weapons systems being procured by the Department of Defense to the production of these systems.

Broader, more systematic studies of this type are urgently needed in order to understand the manpower problem. It does appear, however, that in the aerospace industry there is a residual of personnel capable of doing, or being trained rapidly to do, work of a scientific and technical nature. It appears that some of this residual has been put on NASA work, with the result that the NASA pull on the Nation's pool of scientific and technical manpower has been substantially less than many alarmists have stated.

NASA has a vigorous program of making available to the private sector the scientific advances and technical innovations growing out of the space effort. This is particularly important at the present stage of development of our national economy because of several factors. First, the NASA program of research must include virtually every area of interest from biology to electronics to the effects of zero-gravity. In developing systems for more effective uses of energy; very advanced electronics; new materials, metals, fabrics and lubricants; and the marriage of these with the life sciences NASA is working at the sharpest cutting edge of research in the essential areas that affect and underly economic growth. For this reason, it is especially relevant to the Nation's needs in research and production. Second, the requirements for successful operations in space are harsh; as a result, the greater part of the work carried on by NASA is at the leading edge of the state-of-the-art, and quite often requires advance in the state-of-the-art. For this reason it is rather the rule than the exception that some advance, either in product or in general technological skill, is found in the NASA program. Third, a major part of the NASA effort is involved in the organization of large research and development programs, programs that involve both large and small contractors and suppliers and which require a high level of reliability of component parts and of the system as a whole. Increasingly, this kind of activity is becoming characteristic of design and manufacturing in all fields, and the capability to establish and integrate these kinds of large organized efforts is in itself an advance in the application of technology. This is of special relevance to this Subcommittee in view of the fact that the survival of many small business concerns may in part depend on the ability of some main producer to organize and use efficiently and effectively the products of large numbers of small independent concerns.

At NASA, the effort to make available the results of its science and technology is divided into two parts. The first part, in the Office of Scientific and Technical Information, is designed to collect, to evaluate, to abstract, to index, to store in readily accessible form and otherwise, and to disseminate all scientific and technical information relative to space exploration. These materials are available not only to NASA and its prime contractors, but are also available to the scientific community, to engineers and industrial organizations, and the general public.

A special part of the total job of rapidly disseminating the results of the NASA research and development effort is that of identifying and evaluating as quickly as possible those elements that seem to have applications for industrial use. Within NASA the Office of Technology Utilization has been established to work at this problem. In each of the NASA field centers there are technically trained people who monitor and study the research programs being carried on in order to make initial identification of potential items of transfer. These items are then described and sent to

Headquarters. At Headquarters, a staff of technical people, aided by a number of research institutes, continue the evaluation and analysis of these items. When evaluated and described, these items of potential transfer and use are disseminated in a variety of ways. In addition to the normal channels of publication on a national basis, NASA is seeking ways to establish information centers and sources of knowledge about items of potential transfer at places more convenient to the average industrialist and businessman. For over a year, the Midwest Research Institute has been carrying on a program of helping to identify such items, and of experimenting in a six-state mid-western region with ways to elicit cooperation and action by business and industrial leaders.

At Indiana University, the first pilot model of a university-industry-NASA technology information center has been operating for nearly a year. This Aerospace Research Applications Center is developing means to accelerate the utilization of space technology by all sizes of businesses by providing reference, search and information services to a pilot group of 29 companies. For smaller concerns who do not have their own internal technical library, Indiana University provides such a service. For both the larger and smaller companies who have the problem of handling an overwhelming volume of published technical material, the Indiana Center performs selective dissemination, matching the company's fields of interest to the content of the technical documents received from NASA and stored in the University computer.

Of the 29 companies participating in Indiana's first year, 7 are relatively small. With less than a year of experience in this unique endeavor to find ways to transfer to small as well as large industries the practical applications of space research, a large majority of the cooperating members of the Center are enthusiastic about the results and prospects and will continue their membership. Another 30 companies of all sizes have asked to join next year. A medium-sized manufacturer wrote: "We have already received more than we could hope for. My mouth waters to see the amount of good technology..." One of the smallest member companies stated:

"There is considerable value to us in the ARAC program.... The technical library facilities have been helpful.... We expect future benefits to outstrip those to date." In this way, we are attempting to both speed up the technology utilization process and make it more realistic in terms of the needs of the average business and industrial concern.

In addition as an important component of NASA's multidisciplinary research and grant activities at universities, a number of arrangements have been made with other universities which will bring their capabilities into play in solving this problem of disseminating scientific and technical information, and, especially, of working at the problem of the transfer of the results of research and development to civilian use in as quick and as practicable a way as possible. It is essential to make a breakthrough in this area. The research and development program of the government, as specialized as some of it is, represents a great storehouse of new scientific and technical information and advance. It is a national resource, bought and paid for by the public generally, and it must be put to general economic use as quickly as possible.

NASA's policy is to utilize and strengthen the scientific resources of the universities rather than build competing enterprises. Its policy is also to encourage area and regional patterns of cooperation between industry and university scientific and technical resources. In this respect, NASA in its project work, seeks to place its work in the essential departmental structure or the universities wherever possible, and to couple it with graduate training and research. NASA supports a graduate training program under which training grants have been made to 886 students in 88 different universities. A feature of these grants is the fact that they are made to the institution, to be awarded by the faculty for work at their institution. In this way resources are built in those universities that are seeking to advance their standing, rather than have many of the most promising of these graduate students migrate to a small group of leading universities. At a number of universities where a large amount or project work is already being carried on, NASA has made grants in support of facilities needed to expand this activity, and in support of general work in areas that are related to the the space effort. As a part of the consideration for these grants, NASA obtains assurances that these universities will take a special interest in the matter of making available in their regional settings and in the areas where they have established relationships with industry the vast amount of scientific and technical information growing out of the NASA program. Special emphasis is placed upon bringing items of potential general industrial use directly to the attention of business concerns of the area.

These are some of the ways in which NASA is seeking to discharge its responsibilities in the area of interest with which this Subcommittee is concerned. The solution of the problem of effectively relating technological resources to the growth of the national economy must inevitably involve a broad approach by a large number of elements in our national life.